Using a tracking algorithm to infer the scattering properties of ice in microwave brightness temperatures

A. Martini, , N. Viltard, Yannick de Caqueray-Valmenier, Thomas Fiolleau

Université Versailles Saint-Quentin – CNRS/INSU – LATMOS/IPSL, 11 bd d'Alembert 78280 Guyancourt, France, contact : audrey.martini@latmos.ipsl.fr

GENERAL SURVEY

The subject of the study defines the choice of the instrument and the signal frequency. In meteorology and climate research, space borne passive microwave radiometers for Earth Observation usually operate between 10 GHz to 190 GHz for precipitation observations. Many missions are dedicated to the study of the water cycle in the atmosphere in the context of climate change such as TRMM, GPM and Megha-Tropiques. Because the microphysical characterization of the ice particles in the atmosphere affects strongly the brightness temperatures above 35 GHz, it is one of the main path for improvement for the precipitation retrieval algorithms to be able to characterize the ice properties as a function the observed system life cycle, the region of interest, the season, etc.

MADRAS : The instrument used for this particular study is MADRAS, which is a conical-scanning passive microwave radiometer with channels in the 18.6 to 157 GHz range, onboard the Megha-Tropiques Indian-French (ISRO-CNES) satellite.

TOOCAN : The TOOCAN algorithms tracks the rain systems using the time-series of images from the IR channels of geostationnary satellites.

We are going to study the possible connection between the life cycle of rain systems and their signature in the higher microwave frequency coupling MADRAS and TOOCAN.

TOOCAN, MADRAS

MADRAS

Both channels (here 89 GHz Horizontal) measure brightness temperatures (T_Bs) in the horizontal (H) and vertical (V) polarizations with a resolution of 10x17 km^2. The number of overpasses on a given system is limited to a maximum of 6 per day on a given location. This is why a synthetic life cycle is build from TOOCAN.

TOOCAN

TOOCAN (Fiolleau et al, 2013) is a new generation of algorithm that uses a succession of geostationary satellite images to detect, identify and track rain systems from their initiation to their dissipation. TOOCAN is able to detect and track enough systems to account for more than 90% of the total cloudiness. Here it is used in the Indian Ocean over Gan during the CINDY-DYNAMO experiment in 2011.

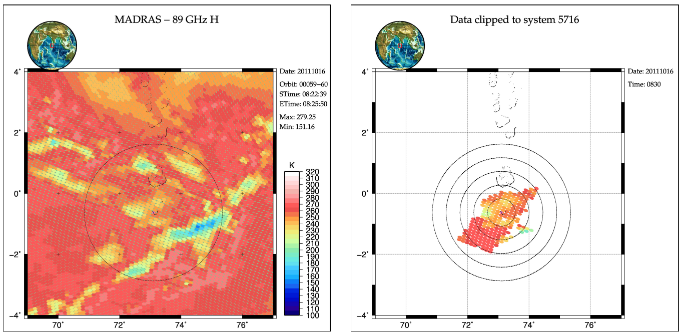

Figure 1: Left-hand side shows the MADRAS 89 GHz Horizontal polarization brightness temperatures corresponding to the image shown on Fig. 2. Right-hand side shows the same 89 GHz brightness temperatures clipped to the 5716 system.

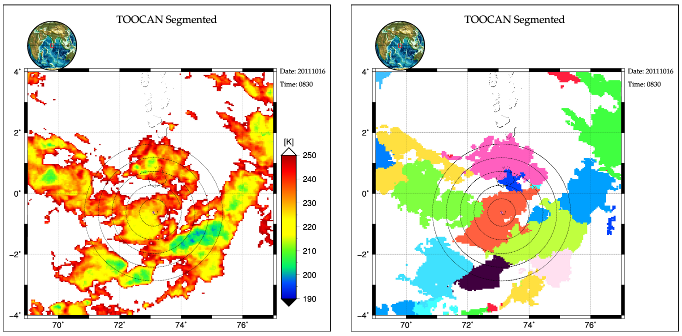

Figure 2: Left-hand side shows the 11.5 µm channel of Meteosat 7 thresholded at 250K on 16 of October 2011 at 0830 UTC. Right-hand side shows different systems uniquely referred with an arbitrary identification number and color. The red system right over Gan is the number 5716.

STATISTICAL OBSERVATIONS
COUPLING TOOCAN AND MADRAS OVER ADDU ATTOL

In the microwave brightness temperatures this evolution of the ice microphysics characteristics should be seen as a strong initial cooling, followed by a progressive warming to get back to the background brightness temperature as the precipitating ice disappears with the dissipation of the stratiform region.

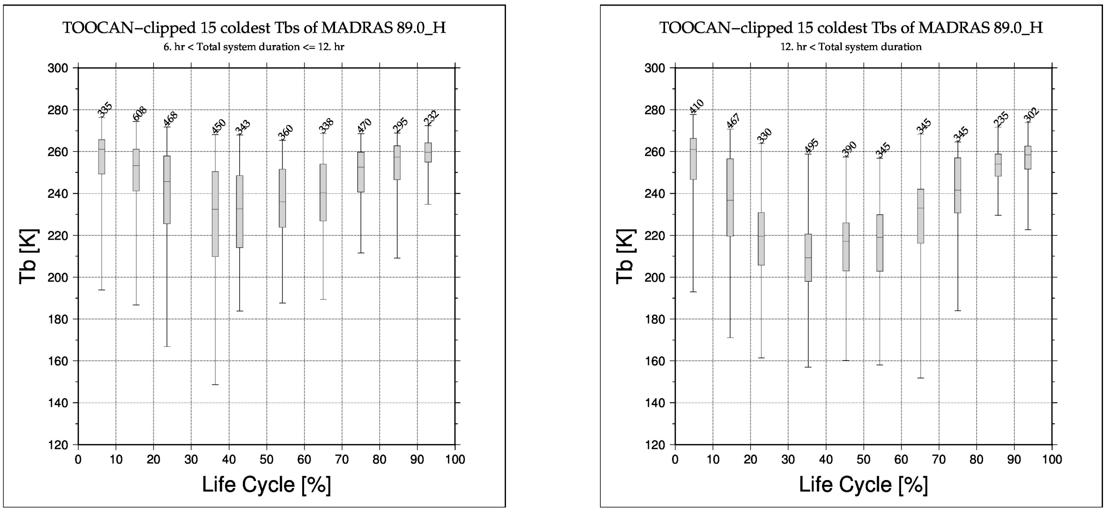

Figure 3: The two figures above show box-and-whisker diagrams of the 15 coldest 89 GHz-H brightness temperatures of all clipped systems as a function of the life cycle (10 % bins) for system with total duration between 6 and 12 hrs (left) and system with total duration longer than 12 hrs (right) .

Conclusions

These results show that there is a rather robust connection between the life cycle of the systems and the 89 GHz brightness temperature signature over GAN. During the first 40 % of the life cycle, the TBs cool off due to the building of the ice concentration in the cold part of the cloud. There seem to be a good statistical connection between the total system duration and the intensity of the cooling. During the second half of the life cycle, when processes are mostly stratiform, the ice injection stops and a slow warming of the Tbs seems to occur until the end of the life cycle.

Unfortunately, it appears that this information is difficult to adapt for retrieval algorithms because the case-to-case variability is extremely high.

Reference

Fiolleau T. and R. Roca, 2013a : An Algorithm For The Detection And Tracking Of Tropical Mesoscale Convective Systems Using Infrared Images From Geostationary Satellite, *IEEE. Transactions on Geoscience and Remote Sensing*, **51**, 4302-4315.